Hampshire 2050 – Economy Theme - Evidence

From: South Coast Marine Cluster

Opportunities in the Emerging Ocean Economy – Draft Contribution to Marine Sector Deal

Headline Market Trends

The 'Foresight Future of the Sea' report estimates that the UK Marine and Maritime Economy to be Ocean Economy contributes around £47 billion GVA and employs more than 500,000 people *(Foresight Future of the Sea 2018)*. This is comprised of established sectors including; Capture fisheries, Seafood processing, Shipping and ports, Shipbuilding and repair, Offshore oil and gas, Tourism, Business services, Education and training, Manufacturing and construction, Research and development.

However, critically the report also addresses the importance of Emerging sectors including; Aquaculture, Offshore renewable energy, Maritime safety and surveillance, Marine biotechnology, High-tech marine products and services, Deep and ultra-deep water and gas, and Marine and seabed mining. Many of these sectors have either a major presence on the South Coast Marine Cluster Region, or have companies leading in key component technologies feeding into the value chain for these sectors.

In a global context, this can be contrasted with the OECD Global Ocean Economy 2030 report that predicts that the ocean economy will reach US$3 trillion by 2030 (this being more that 2.7% of world GDP), more than doubling its 2010 contribution and being driven by growth in aquaculture, offshore wind, fish processing, and port activities, with offshore wind is predicted to be one of the biggest areas of growth. This also being picked up in the Foresight report which recommends that the UK Capitalises on the significant potential of the offshore renewable energy sector, by building on and learning from the UK's experience in offshore wind.

The Foresight report flags the requirement to work with key sectors to create a long-term platform for UK businesses to capitalise on growing global opportunities presented by the requirement for data required for offshore operation afforded by the cost and safety advantages of marine autonomy and robotics, transmission and remote sensing via satellite communication, in addition to a need for more traditional hydrographic surveying and mapping. All such data, then needing interpretation via marine science, in order to inform and optimise operations, and to feed into policy making decisions to safeguard a healthy and productive ocean environment.

Enablers for Success

The Foresight Report highlights the need to better capitalise on the UK's science, technology and engineering base to ensure the strengths are effectively translated into innovation and growth in the marine economy. This is also reflected in the DFT Maritime Growth Study that flags the importance of Innovation, Clustering and Stability as being key enablers for the sector to develop, flagging the importance of marine technology companies to economic growth. This being enabled by close collaboration between Government, Industry and the Research Base (so the Triple Helix).

The report also references the importance of the EU Blue Growth agenda, that seeks to develop sectors that have a high potential for sustainable jobs and growth, with essential

components being the need to provide knowledge, legal certainty and security in the blue economy. Another issue raised is the importance of access to finance for Innovation, and how research, innovation and creativity are the key enablers of enhanced productivity. Clusters are specifically referenced as an important component to driving growth, flagging both the Solent and Plymouth Clusters and how these are crucially important to enable the UK to compete with those in Hong Kong and Singapore.

Priority Areas for Marine Growth in the SCMC

Advanced Manufacturing

The South Coast has clear strengths in marine manufacturing and technology used to deliver innovation extending far beyond the sector for applications within aerospace and automotive.

The international reputation for leisure marine and world-class Superyacht design makes a significant contribution to the UK's world-leading reputation for vessels of high quality and high-value Our strengths in innovation and technology, such as composites manufacturing, supports the marine sector and provides transferrable skills for other sectors such as offshore wind and tidal energy companies.

- Companies based in the region, BAR, RAC, Vestas……
- Need access to technology providers, to work collaboratively to solve problems – generic ones for a group of companies and individual.
- SCMC should be a community and facilitate interaction between industrial partners and academia, and B2B, to develop growth and income
- Keying into the Government aim to raise R&D funding from 1.6% to 2.4% of GDP

What we have:

- Across the south coast is a wealth of experience and expertise in marine manufacturing, with the individual components required to deliver world leading products. Renowned organisations that set industry standards for design, research, manufacturing and testing, help the SCMC to deliver world leading products that enhance the UK'S Ocean Economy offering.
- Daedalus Enterprise Zone - designated in 2012 with the aim of creating a new cluster of principally engineering and manufacturing businesses focusing on aviation, aerospace and marine sectors. It includes a new advanced engineering college, the Centre of Excellence for Advanced Manufacturing Skills Training (CEMAST), providing over 1000 student training places in aviation, marine, vehicle and electronic engineering.
- Dorset Innovation Park Enterprise Zone, an advanced engineering cluster of excellence, building on strengths in marine, defence and energy
- National Composites Centre in Bristol, one of the seven centres of the High Value Manufacturing Catapults. It brings together businesses and academics to develop new technologies for the design and rapid manufacture of high-quality composite products and provides manufacturing facilities at an industrial scale, enabling rapid manufacturing processes capable of building prototypes to validate design concepts. It also provides direction and focus for fundamental research and collaborative links with UK universities, helping to co-ordinate training that supports the skills base necessary for applying advanced and specialist composite technologies.

- The National Oceanography Centre (NOC) based in Southampton is one of the world's leading oceanographic institutions, providing the UK with the national capability needed to be a global player in leading and participating in international projects. The NOC undertakes world leading research in large scale oceanography and ocean measurement technology innovation, working with Government and businesses to commercialise great science and technology. The NOC supports the UK science community and smaller research institutes with scientific facilities, research infrastructure and data assets, enabling the UK to harness the full power and diversity of its scientific talent in ocean science.
- The Southampton Marine and Maritime Institute (SMMI), based at the University of Southampton, with extensive materials and structures testing facilities and expertise, including the National Infrastructure Laboratory (NIL), for testing large structures (due to open Q1, 2019)
- Lloyd's Register's Global Technology Centre, at the Boldrewood Innovation Campus, one of the worlds leading providers of professional services for engineering and technology – improving safety and increasing the performance of critical infrastructures.
- The Maritime and Coastguard Agency (MCA) based in Southampton, responsible for safety affecting seafarers and vessels in UK waters, environmental issues and certification.
- The national Centre for Advanced Tribology at Southampton (nCATS), a multi-disciplinary tribology centre focused on wear and corrosion, that develops novel self-repairing, adaptive, regenerative multi-functional surfaces for smart applications

The opportunity:

- Developing the supply chain to ensure it is efficient and well understood, will provide opportunities for the Original Equipment Manufacturers (OEMs) and the supply chain that feeds it, potentially driving further innovation and increasing capability.

- UK shipbuilding industry retains global leadership in high-value manufacturing, including defence, research and luxury vessels. SCMC is home to 20% of UK marine manufacturing, including significant sub-sea expertise.

- Industry expects that the innovations required by environmental regulation may offer new opportunities for the UK's specialised shipbuilding, and Department for Transport has identified the design and manufacture of superyachts, high-end powerboats and sailing yachts as a major opportunity.

- The UK is also a global leader in subsea engineering, a sector the industry values at £8.9 billion a year, with significant export potential and wide-ranging applications.

Gaps/investment requirements:

- Supply-chain development – Development of an efficient supply chain, enabling large and small businesses to work together more effectively.
  Investment required in: enabling collaboration that delivers for the sector and the UK as a whole. Focus on dialogue within the sector to support future skills requirements, strengthening the position of the cluster and enhancing its attractiveness as an inward investment location.
- Design and manufacturing techniques - Innovation in design and manufacturing techniques is critically important across all of the priority opportunities.

Investment required in: Development of tools, processes and facilities to integrate and improve design, modelling and manufacture, considering overall efficiency, reliability, intelligent user-centred design, the full vessel lifecycle and automation

- Structures and materials - The area is fundamental to composites and novel materials, and highly important for specialist vessels, through-life operation and insertion, and superyachts and high-end leisure.
  Investment required in: Developments to increase acceptance of composite and novel materials including self-healing structures, corrosion-free metals and metal composites to reduce weight and corrosion

Marine Autonomy

Marine Autonomy is a truly disruptive technology that has the potential to replace traditional ship- based alternatives for equipment inspection and other marine monitoring operations. Ships have very high CAPEX and OPEX, but the daily operational cost of a MAS could be as low as 4% for some applications when compared to current ship-based alternatives. Increasingly employed for 'Dull, Dirty & Dangerous' operations, marine autonomous platforms (both surface and sub surface) can be fitted with an application-specific sensor suite to capture whatever data is required for a given location. A Marine Autonomous System (multiple surface and sub-surface platforms with sensor suite for specific function) in this context in not to be confused with Autonomous Shipping, although some component technologies, Artificial Intelligence protocols and regulation, will potential apply to both.

Typical future applications for which systems are currently under development include subsea pipeline / cable inspection, mine counter measures and anti-submarine warfare applications in defence, and monitoring systems to verify the integrity of Carbon Capture and Storage sites.

Autonomy is defined as as one of the '8 Great Technologies' as identified by BIS, and in a recent McKinsey study in 2013 it was found that Advanced Robotic Autonomous Systems (RAS) would generate a global economic impact of $1.9 trillion to $6.4 trillion per year by 2025 (RAS SIG 2014). The sector has grown significantly in the last ten years, in the more recent 10 Year Market Assessment for Intelligent Maritime Mission Systems conducted by Renaissance Strategic Advisors found the total global market over the ten year period 2015 – 2025 to be £42.43 billion (Renaissance Strategic Advisors 2015)

Further analysis from the MAS Initiative Brief prepared by the Marine Industries Alliance, RAS SIG, UK NEST 2014, based on the Douglas-Westwood 2010 Report (2010) stated the following:

- The overall Defence and Civil markets are estimated to be worth $136 billion within the 2014- 2030 timeframe
- Market split in 2014 was 23% AUV and 77% ROV with a Compound Annual Growth Rate of 22.5% and 7% respectively
- Projects that the Global AUV fleet will increase 42% between 2014 and 2018
- The UK also has 7 top ROV/Autonomous Underwater Vehicle component manufacturers and a vibrant Sub Sea Technology Industry

The importance of marine autonomy and robotics is also flagged in the Foresight Report that flags that the UK has significant relevant research strengths in this area, along with a number of innovative marine autonomy small and medium enterprises. They flag that industry predicts a global market of $136 billion over the next 15 years with the UK adopting a 10 per cent UK market share. It is also referenced in the DFT growth study, which refers to the UK Marine Technologies Roadmap, that specifically prioritises the design and

manufacture of autonomous surface and underwater vehicles with associated intelligent systems

Key challenges remain though, and whilst sensor technology is a key enabler, further developments are still required around data quality and accuracy, connectivity, processing and resilience (Global Marine Technology Trends, Autonomous Systems 2017). Cyber Security, Energy Management and Regulation are also highlighted as key challenges to address for the sector.

The South Coast Marine Cluster Marine Autonomy Footprint

Currently within the SCMC region are the vast majority of UK platform producers including ASV Global Ltd, BAE Systems, Hydroid and Most-Autonaut (partnering with Seiche), M-Subs and Saab Seaeye. Whilst the SCMC Saab and Hydroid operations are part of multinational companies, the Saab presence in the area specifically focuses on defence marine autonomy. Hydroid, a US company who are part of Kongsberg, was formed only 15 years ago, and is already turning over in excess of $160m. ASV produce surface platforms and started with just two employees in 2010, and now have in excess of 100 employees and offices in the US and Brazil.

A Marine Autonomous System goes just beyond the platform though, and requires sensors, positioning and communication technological components to perform its function. Again, the SCMC region hosts the majority of companies operating in this area including Sonardyne, Seiche, Valeport, Planet Ocean and Chelsea Instruments. Furthermore, Roke Manor Research Ltd, an R&D business for communications, networks and electronic sensors, are interested in pursuing the use of MAS for security applications. It is highly likely that there are other component supply chain companies within the region, but as yet, no supply chain mapping has been carried out.

R&D Spend from Specific Companies on the South Coast.

ASV Ltd - UK turnover is approx. £14m and staff count is approximately 110. Currently around 15% of turnover as investment in R&D, with most of this matched by grant funding from the likes of InnovateUK.

Planet Ocean - Current Turnover of £2.2m and staff count of 8. Approx value of R&D spend of £100k each year and planned investment into new facilities etc - 2018 £ 100 – 150K, 2019 £ 200K - 300K

MSubs Ltd - Current Turnover of £10m and 55 staff, with annual R&D Spend of £500k. The company is intending to expand premises to take in waterfront and double our footprint, which will equate to £1.5m investment.

Also hugely significant is the world-leading research expertise relating to MAS in the immediate region. The National Oceanography Centre (NOC) is not only Europe's biggest customer of MAS, but it has a strong pedigree of developing its own systems that have been deployed in the world's most challenging ocean environments. The NOC opened its Marine Robotics Innovation Centre in 2016 and now has over 27 partner companies within this conducting R&D valued in excess of £15m

In addition to the NOC, the University of Southampton (UoS) has already developed its own Delphin autonomous platform and is a globally leading University with a key emphasis on Marine & Maritime. It has recently established the Southampton Marine & Maritime Institute (SMMI) and has world-leading testing equipment, including that within the Systems

Reliability Laboratory, part of which is located in the NOC Innovation Centre. UoS also lead NEXUSS which is a NERC/EPSRC collaborative Centre for Doctoral Training focussed on autonomy with multiple other partners, including the NOC.

QinetiQ locally also have world-leading test facilities that are accessible for MAS testing as represented by QMAC (QinetiQ Marine Autonomy Centre), and are helping the Royal Navy to establish and manage the Unmanned Warrior Exercise (deployment of multiple MAS). The Centre for Marine Intelligent Systems has been established in Portsdown focussing on the Synthetic Environment for the use of MAS, and both Solent and Portsmouth Universities also have expertise relevant to Autonomy as evidenced by Solent's recent success with an Innovate UK MAS project, and Portsmouth's lead to establish a Centre of Excellence that will look at the use of satellites and autonomy.

'Offers' and 'Asks' for Marine Autonomy

Ideas

Several Expressions of Interest have already been submitted under the 3rd Wave of the Industrial Strategy Challenge Fund that will have direct engagement with SCMC MAS companies, including the following:

- SEAS Safe Environmental Autonomous Systems (SEAS) A proposal to map the UK Sea Bed seeking to develop safe environmental autonomous maritime systems in two nationally critical areas: seabed mapping and green shipping. Unless overcome, this will prevent the UK from capitalising on major economic opportunities (ca.£16Bn) from and relegate our responsible stewardship of the sea.
- Sea Bed Minerals. Submitted by UK Seabed Resources that would include the use of MAS for both prospecting and environmental impact assessment

The key to growth for Marine Autonomy, is the development of a system (platform + sensors + positioning and communications technology) for a specific application that can make use of the cost and safety advantages of the technology. Examples here include pipeline and cable inspection, leading to commercial opportunities for companies supplying the technology, but also for companies offering cost-effective data acquisition as a service, such as Blue Ocean Monitoring in the NOC Innovation Centre. Other key market opportunities also exist for the development of application specific Marine Autonomous Systems, including key growth areas flagged in the Foresight Report including:

Decommissioning

The Foresight report states that market is growing, with an estimated £17.6 billion is forecast to be spent on decommissioning on the UK continental shelf between 2016 and 2025. Although there are uncertainties around the economic and environmental implications of large-scale decommissioning, this potentially presents the UK with an opportunity to use its expertise in offshore oil and gas to develop world-leading capability. Foresight discussed how the UK supply chain could offer highly skilled employment, especially to those who previously worked in oil and gas extraction, and the opportunity to export goods and services to the growing global decommissioning market. Opportunities for the UK are particularly likely to be in processing these structures on land, but critically for SCMC in the development of Marine Autonomous Systems for ongoing monitoring, that owners of such infrastructure will have to conduct in perpetuity.

Carbon Capture

UK is committed to reducing its CO2 emissions to 80 per cent of 1990 levels by 2050 (Foresight). CCS involves the capture of CO2 from emissions, which is then injected either into the deep sea, depleted oil and gas fields or layers of rock, with CCS having the potential to store 40 per cent of UK CO2 emissions by 2050. Foresight Report flags that the UK has a significant CCS research community, but the other major advantage for the SCMC is the potential for Marine Autonomous site monitoring solutions to be developed (see ETI funded CCS project with NOC, Southampton and PML). In 2015, globally there were 13 plants capturing CO2 using combustion processes, 11 using pre-production processes and one using oxy-fuel. A further 9 projects were sourcing CO2 from industrial processing (Global Marine Technology Trends 2015). The Global Marine Technology Trends report flags how every plant would generate thousands of jobs, providing the opportunity to continue to use cheap energy sources for continued economic growth.

Deep-Sea Mining

Ferromanganese crusts in the Pacific are estimated to contain about seven times more cobalt, widely used in batteries, than land-based reserves, with polymetallic nodules offering potential resources for rare-earth metals and industry is currently exploring the feasibility of mining these resources (Foresight). Seabed mining could still be worth £40 billion to the UK over the next 30 years with the UK could taking a lead in the industry, due to its relative skills and experience in deep-water oil and gas extraction, which also offers export opportunities for the UK's supply chain.

Opportunities are around MAS for prospecting and also marine science application to understand the environmental impact of operations, with the Global Marine Technology Trends report flagging how autonomous systems will enable the economic harvest of these valuable minerals.

People

Skills shortages are a major issue affecting SCMC MAS companies, with many of the companies in the Solent region inadvertently competing for the same workforce. Other specifics raised by companies include:

- 'We certainly need more people in the team with high level software development skills. This would be our main ask, people with machine vision, AI, sensor fusion, C++, Python, mathematics/algorithm skills'

- 'The specific skills required for "marine robotics" are in short supply and better serviced from overseas, especially, Italy, France and Germany. However we do see a significant shortage of <u>experienced</u> engineers and technicians in all areas (Mechanical, Electronic, Electrical, Software, Systems) Small companies do not have the resource to provide early career training. For us, skills incubators such as the NOC MRIC would be an excellent way of providing this experienced resource through the MARS team, although my assumption is that the MARS team would rather hang on to these people for their own use.'

- 'Biggest problem we have is getting enough qualified people – there is, as you know, a shortage in skilled engineers. We are investing in the future by funding our senior staff's children through a BS in engineering provided they work for us upon receipt of degree for three years and then we invest in getting them chartered and an MS in three years, after graduation. We're also working with local colleges to bring in

apprentices for our machine and metal fabrication shops as there is an even more worrying dearth of people in those fields.'

Infrastructure

Testing Ranges

A recent Solent LEP investment for a Surface Vehicle testing range, combined with the work going on in Plymouth, and the QinetiQ/MOD ranges and sites like Fort William, means that Testing Ranges do now exist for MAS trial and demonstration. One company questioned highlighted a gap around a need for sites/support for port operations/mobility/logistics and how we can prove MAS in these environments.

Testing ranges that will be used for underwater vehicles will also require instrumentation. As one company responded; 'for any testing range to be really useful for underwater vehicles, a permanently installed and calibrated acoustic tracking range would be essential. This would include USBL/LBL as well as 3D pinger tracking. In addition an acoustic noise measurement capability would be extremely useful. These resources do exist in the UK but are expensive to use, remote and MOD has priority. Access to deep water > 250m is a geographical limitation of the UK. agreements with non UK ranges that do have deep water facilities with UK subsidised access would be very useful. Ashore facilities with good communications, workshops, and a range of boats are required to support this. Underwater infrastructure such as sonar targets, lengths of pipeline and cable would be useful. It is well known that these ranges need to be carefully described during planning and operation to avoid the public concern regarding testing of other autonomous technology emanating from the bad press associated with autonomous cars and drones.'

To help address this gap, another company who responded said that 'We're already building our own range. We have numerous cameras, radar, AIS, Anemometers, and broad-band comms stations set up on Plymouth sound so that we can communicate with our unmanned systems at sea and monitor all testing, and have a direct CIC link. We have not installed and UW system but are planning to do so in the near future; water depth (shallow) is the impediment there but we are working on it and should expand our surface comms system to cover more than 100kmsq by the end of this year.'

Business Environment

Grants / Funded Support

Most of the companies who engaged in this study are engaged in R&D that is supported by funding agencies like Innovate UK, and those engaged with this wanted this to continue:

- *'Continuing support from InnovateUK for future, high risk, high return development that will lead to additional job creation and export sales.*
- *R&D grants are relatively simple to apply for and manage once awarded. They do of course require some element of fund matching and so limit access to those that have sufficient resources to provide the 30-40% funding gap.*

R&D Tax Credits were also welcomed by the companies who responded:

- *R&D Tax Credits etc, are now an established resource to UK companies if they meet the criteria. They appear to cover a useful range of funds from a £1000 – upwards.*
- *We do take great advantage of the R&D tax credits and that has helped us immeasurably, in growth and stability.*

One company also commented on the gap in funding for the 'Valley of Death' phase beyond R&D and before commercialisation:

- *'It is a well know problem that once the innovation/R&D funding expires, there is little funding available to take the product to market so that the innovator and the funder can see a return. At this stage recipients are vulnerable to hostile VC involvement, debt financing or non-favourable equity financing (some of which is offered through government (Rainbow seed fund for example)) all of which are not attractive given the likely TRL level of the technology and private investment already injected at this stage. This seems extremely short sighted of government, and many projects which have good potential for investment recovery fail at this stage because of this. There are some creative schemes emerging from banks and now UKRI that provide some other options but still at high risk and which favour the gambler.'*

Other comments included:

- *'My personal experience is that LEP funding is not useful in our sector. As you know we have significant concerns regarding licencing and IP where 100% funding has been provided by the industrial partner to the academic partner. Recent discussions I have had with UKRI indicates that they now acknowledge this and agree that academics should be treated as "sub-contractors" in these circumstances where IP and knowhow is effectively commissioned and become the property of the fund provider to use as they see fit.'*

New Funding Mechanisms to boost growth

Although existing grant mechanism are welcome and should continue, additional ideas received from companies were new mechanisms to support Procurement, and to stimulate the use of new UK technology by Government Departments:

- *'What would also be useful is funding to support users/applications, so funding for organisations likes the NOC, MCA and Environment Agency to encourage use of unmanned systems along the lines of the SBRI model'*
- *If we look at our US competitors, it would appear that their R&D and subsequent growth is largely underwritten by the promise (pretty much bankable) of significant government contracts at various stages to enable the onward development and establishment of the technology in a planned and growing way. This is of course not universal, and seems to be reserved for genuinely useful and leading edge technologies with proven pedigree and performance.*

Place

Access to suitable waterfront sites for business expansion is certainly an issue in the East of the region:

- *'this is a challenge particularly to the Southampton and Portsmouth Areas. As a company we need approximately 50-75,000 sq ft next to the water with dock/slipway facilities, this is proving incredibly difficult to find. There are lots of small office/workshop opportunities for micro and startup companies but much less available for next stage and scale up organisations in the marine sector.'*
- *'Certainly when the time comes for us to establish ecoSUB in its own facility waterfront or close waterfront facilities will be very close to the top of the requirement list. There are a number of UK regions seeking to be the focus for marine autonomy, whilst access to "national" resources such as wave tanks, flumes, pressure and environmental testing facilities etc will be a very important consideration so will be locally provided subsidies in terms of the rents, rates and staffing.'*
- *'We're about to acquire waterfront premises – the lack of available sites is a significant impediment to growth and we are considering opening offices in another*

area of the UK that would afford direct access for our products, to the sea. Still, we're working on it and using local marinas'

Satellite Communications

As flagged by the Foresight Report, Satellite communication will be a critical enabler for autonomy, and associated expected growth in autonomous shipping and big data collection at sea with applications including monitoring of illegal activity including fishing. Critically, this is an enabling technology for the data transfer and communication between autonomous vehicles and satellites in the next few years. This also critically dependent on the miniaturisation of sensors to enable easier collection of core data at a large scale (Global Marine Technology Trends 2015).

The Satellite Applications Catapult has a Centre of Excellence both at the NOC in Southampton and also at Plymouth is already capitalising on the UK's strengths in this sector, working with the Pew Charitable Trusts in Chile to monitor illegal fishing off its coastline.

Data, and specifically Big Data Analytics is also flagged in Global Marine Technology Trends (2015) as a key growth area highlighting a need for the development and exploitation of technologies to address the big data challenge as the volume of data continues to rise exponentially. Specifically developments are required for predictive analysis and smart pattern-discovery techniques for use in autonomous systems, seeking to effect situational awareness. The more general application here being enhanced monitoring of the ocean environment on which all blue growth will depend.

Aquaculture

The Foresight Report flags that by 2030 the industry is projected to provide over 60 per cent of fish destined for direct human consumption, with the UK seafood sector valued at almost £800 million in 2014. Currently production is focussed on Scotland, with Atlantic salmon forming a major component valued at £519 million in 2012, with the UK having the opportunity to increase production with new technology for growth markets in China, Japan and North America.

Another market highlighted by the Foresight report is for UK marine sciences as consultancy to inform rapidly growing aquaculture industries in other areas of the world including Southeast Asia. Another opportunity for the SCMC area is for Green Biotech developments to produce oil seed crops are able to deliver both vegetable oils and protein meals for aquaculture feed of the future.

There are also opportunities for aquaculture to co-locate with other offshore infrastructure, e.g. renewable energy generators.

Hydrography

The Foresight Report highlights that there remains a high amount of uncertainty about the topography of the seabed, with a significant proportion of the UK's domestic exclusive economic zone (EEZ) is unmapped at high resolution for hydrographic purposes. This being important for safe shipping routes, marine ecosystems, seabed morphology and movement and marine spatial planning including the safe positioning of offshore infrastructure.

NOTE UK Hydrographic Office in SCMC PATCH EXPAND (having primary charting responsibility for 71 countries around the world).

Renewable Energy

The Foresight report states that the industry is going through a period of rapid growth due to technological innovation reducing the cost of electricity generated. 13,000 direct and indirect jobs in the UK supported by offshore wind, and this is predicted to increase to 44,000 by 2023 with the UK offshore wind industry could being worth £2.9 billion to the UK economy by 2030.

One of the biggest opportunities in the sector is operation, maintenance and service sector of offshore wind, a market where many UK SMEs operate in

Wave and tidal energy has the potential to meet up to 20 per cent of the UK's current electricity demand, with 1,700 people employed in the sector in the UK. Methods include Tidal barrages, tidal lagoons and tidal stream that has the potential to generate between 17 TWh/ year to 197 TWh/year. Wave energy currently only contributes 8 per cent of the electricity generated from tidal

Key development sites in the SCMC region include Sound Bristol Channel, Minehead Barry Bristol Channel, Bristol Channel, Mackenzie shoal, Isle of Wight and Portland Bill.

Foresight claims that the marine energy industry could create 20,000 skilled jobs in the next decade, contributing £4 billion to UK GDP by 2050, based upon tidal and wave being both predictable and reliable, and an ability for installations to also help reduce flood risk from sea level rise. The Global Marine Technology Trends report also flags the importance of combining offshore renewable energy installations as multi-use platforms, here combining them with Marine Biotechnology Plants, to harvest marine biological resources such as algae for food, biofuel, fertilisers, pharmaceuticals and cosmetics production.

Offshore Wind – SCMC opportunities

2017 was a record year for European offshore wind: 3.1 GW of capacity installed in 2017, double the capacity installed in 2016 which means European offshore wind capacity has grown 25% to 15.8 GW and there are now 94 grid-connected wind farms and 4,149 turbines. Offshore wind turbines are getting bigger: the average size in 2017 was 5.9 MW, 23% up on 2016. Offshore wind investments in Europe saw €7.5bn in Final Investment Decisions (FID) for a total capacity of 2.5GW in UK and Germany. The US is catching up. In 2016, Deepwater Wind completed the commissioning of the Block Island Wind Farm off the coast of Rhode Island, marking a milestone as the first commercial offshore wind project in the U.S. There is increased confidence in the U.S. offshore wind market caused by decreasing global costs and stronger state policy commitments and several states including Massachusetts, New York, and Maryland have enacted new policy or bolstered their existing policy to support the development of over 4,000 MW of offshore wind so that today, the U.S. offshore wind project development pipeline includes over 20 projects totaling 24,135 MW of potential installed capacity.

This represents significant market growth, and opportunity. The global wind energy market (offshore) is projected to surpass $57.2 billion by 2022 (NREL) as part of a $170 billion market (on and offshore) with over 13 GW of annual installation by 2024 (Global Market Insights). Current estimates for UK businesses suggest capturing around 8% of this global market. Growing demand for reliable, cost effective and environment friendly generation systems along with strict government norms to reduce GHG emissions will augment the wind energy market. In 2016, government of UK announced the target to reduce GHG emissions up to 58% by 2030 from 1990 levels. Key industry players across the wind energy

market include Vestas, ABB Limited, General Electric, Siemens Gamesa Renewable Energy, Nordex, Enercon, Suzlon, Doosan Heavy Industries & Construction, Senvion, and Vattenfall. Several of which it will be possible for UK supply chain companies to engage with within the UK market development space, and internationally.

Crown estate's next leasing round for offshore wind is anticipated to start early 2019 (but may start earlier). Currently, the UK has 5GW of installed capacity meeting around 5% of the UK's electricity demand. A further 4GW is under construction, 2.2GW has CfDs in place, while 6.1GW is consented. The Clean Growth Strategy suggested a further 10GW could be developed in order to meet the UK's low carbon ambitions and provide security of supply. Challenges and opportunities rest around project scale, developing projects in accordance with market demand, creating balance and reducing uncertainty alongside other sea / seabed users, all of which auger well for businesses in the SCMC region who have the breadth of technical services on offer to help resolve the many challenges.
Moreover, the potential for some of this growth in areas to be in water depths of greater than 50m will be met by the development of floating wind. The Carbon Trust (Floating Wind Joint Industry Project - Phase I Summary Report) highlights that the industry aspires to a global capacity of 8GW by 2030. To achieve this, there are significant opportunities arising out of the industrialization of the supporting technology including, but not limited to, electrical systems/ cables, moorings, infrastructure and logistics.
Overall, the key challenges which will need to be met in order for this global market to be fully exploited can be summarised around Risk Reduction and Cost Reduction. Put simply, there are vast arrays of opportunities to develop solutions which provide iterative improvements with commercial benefit. Given that this is a region of SME's, with a track record of providing innovative solutions, coupled with research institutions with a strong marine/ engineering capability, the potential of the South Coast benefitting directly from the global market is huge.

By way of example, some of the key areas of activity taking place in the region which are directly applicable to offshore renewables include:

- Concept, Detailed and Production Engineering
- Software Development/ Digital Products,
- Marine Operations,
- Geotechnical and Geophysical,
- Drilling,
- Autonomous vessels,
- Subsea operations and Diving,
- Hydraulics,
- Composites,
- Electric drives, hybrid systems and efficiency
- Fabrication,
- Telemetry,
- Subsea sensors,
- Hydrographic survey,
- Vessel design,
- Naval architecture,
- Pontoon design and manufacture,
- Fendering,
- Moorings and anchoring,
- Project management,
- Collaborative projects

More specific examples of how South Coast market led innovation applicable to offshore renewables include:

- The development of Mermaid by Mojo Maritime, a software package which simulates marine operations against hindcast data to properly understand, and engineer mitigations for, weather risk help change the way some Offshore Wind developers plan their projects,
  In response to industry need, LDD created a pile-top relief drill in a matter of months in order to help install monopole foundations at Gwynt-y-Mor;
- Designed for use by the offshore industries and with the ability to operate long endurance applications in the open ocean, Swathe Services are developing autonomous vessel technology intended to work as a force multiplier with a mother vessel and will integrate increased payloads to provide the launch and recovery of Unmanned Aerial Vehicles (UAVs).

Sector Development Framework – SCMC

A. Commercial Proposition

SCMC offers a business opportunity of £xxm focussed on 3 core areas. Note that high value manufacturing overlaps all three:

1. £xxm Offshore wind	• Predicted to be one of the biggest areas of growth globally from 2010 to 2030, both in terms of GVA to the global 'ocean economy' (<1 per cent to 8 per cent) and employment (+1257 per cent) • Specific opportunities lie in exporting the UK's expertise, for example in operation and maintenance,70 to growing overseas markets.
2. £xxm High value manufacturing	• UK shipbuilding industry retains global leadership in high-value manufacturing, including defence, research and luxury vessels. SCMC is home to 20% of UK marine manufacturing including significant sub-sea expertise. • Industry expects that the innovations required by environmental regulation may offer new opportunities for the UK's specialised shipbuilding, and Department for Transport has identified the design and manufacture of superyachts, high-end powerboats and sailing yachts as a major opportunity. • The UK is also a global leader in subsea engineering, a sector the industry values at £8.9 billion a year, with significant export potential and wide-ranging applications.
3. £xxm Marine autonomy & robotics, incorporating - satellite communications - hydrography	• Expected to be the most significant technological development for the marine economy, transforming the majority of marine industries and sectors, notably monitoring and mapping, maintenance of offshore infrastructure, and shipping • Predicted global market of $136 billion over the next 15 years with a 10 per cent UK market share • Enabler: satellite comms. Critical to support growth in autonomous shipping and big data collection at sea. Industry expects a growing focus on improving data transfer between autonomous vehicles and satellites. • Enabler: hydrography: almost all activity in the marine environment is at least partly supported by seabed mapping, which provides information on safe shipping routes, marine ecosystems, seabed morphology and movement and marine spatial planning including the safe positioning of offshore infrastructure. There remains a high

	amount of uncertainty about the topography of the seabed and a significant proportion of the UK's domestic exclusive economic zone (EEZ) is unmapped at high resolution for hydrographic purposes.

B. Assets

The Great SW area is home to a range of natural assets from Portland Port in Dorset and Appledore in North Devon to Falmouth Harbour in Cornwall which is the third deepest natural harbour in the world. It has the largest Naval Dockyard in Europe, the RNLI and a number of excellent research facilities including:

- Dynamic Marine Component Test Facility (Exeter University)
- Fab Test (Falmouth);
- Coastal, Ocean And Sediment Transport (COAST) laboratory (University of Plymouth)
- MARINEi - A pioneering programme designed to help the marine technology sector in Cornwall and the Isles of Scilly grow through research, development and innovation.
- Marine Business Technology Centre (Oceansgate) – A centre to provide support services and networking opportunities for marine businesses, academia and government. Offering in-sea testing capabilities, which will enable businesses and research establishments to test prototypes for autonomous devices, sensors, instruments, and environmental monitoring devices as well as other analytical equipment.
- PRIMaRE - A consortium of marine renewable energy experts across higher education, research and industry which have joined together to establish a 'network of excellence' centred in the south of the UK.
- Marine Institute and Blue Environmental Hub (Plymouth University);
- North Devon Tidal Demonstration Zone;
- Plymouth Marine Laboratory;
- The Met Office;
- UK Hydrographic Office; and,
- Wave Hub.

It also benefits from the facilities such as the National Composites centre (now the ***National Catapult Centre***) in Bristol and contains a number of dedicated business parks and Enterprise Zones including the ***Dorset Innovation Park Enterprise Zone***, the ***Marine Enterprise Zone in Cornwall*** and ***Oceansgate in Plymouth***. Additionally, the South West Marine Energy Park builds on the region's unique mix of renewable energy resource and home-grown academic, technical and industrial expertise

C. Realising the Opportunities along the South Coast

Investment is recommended in five areas of technical capability that show exceptionally close alignment with the areas of opportunity:

1**. Autonomous systems -** Autonomous capability is fundamental to both the design of autonomous vessels; and decision-support systems.

- Investment required in: Developments in safety, reliability, endurance, communications and regulatory aspects leading to full individual vessel autonomy, with common underlying information architecture standards

2**. Design and manufacturing techniques -** Innovation in design and manufacturing techniques is critically important across all of the priority opportunities.

- Investment required in: Development of tools, processes and facilities to integrate and improve design, modelling and manufacture, considering overall efficiency, reliability, intelligent user-centred design, the full vessel lifecycle and automation

3. Electronics, sensors, communications and control and data management- These are highly important to whole ship integration, design of autonomous vessels, specialist vessels, through-life operation and insertion, and decision-support systems and moderately important to superyachts and high-end leisure vessels.

- Investment required in: Technology to include reduced-cost high-bandwidth real-time communications, internal and external situation awareness to improve vessel operational efficiency

4. Energy efficiency and environmental protection - This area is extremely important to through-life operation and insertion and superyachts and high-end leisure.

- Investment required in: Technology to improve vessel efficiency covering mechanical and electrical systems, emissions, coatings, waste and ballast water management, and noise and vibration reduction

5. Structures and materials - The area is fundamental to composites and novel materials, and highly important for specialist vessels, through-life operation and insertion, and superyachts and high-end leisure.

- Investment required in: Developments to increase acceptance of composite and novel materials including self-healing structures, corrosion-free metals and metal composites to reduce weight and corrosion.

Ideas	People	Infrastructure	Business Environment	Places
• Satellite Applications Catapult: xxxx e.g. • Innovate UK targeted activity • University collaboration • Innovation Centre • • Industrial Strategy Challenge Fund opportunities	• Institute of Technology: xxxxx e.g. • Use of local Digital Skills Partnership • Skills Escalator programme	e.g. • new road access to development site • Ultrafast/ 5G broadband capability	• Business Forum: understanding and responding to the needs of industry, strengthen industry input to the development of the approach & develop industry 'voice' to Govt & other stakeholders e.g. • Supply chain programme • Export programme • Inward investment activity	• Oceansgate, Dorset Innovation Park & Marine Enterprise Zone: major anchor 'assets' to develop inward investment proposition

Grand Challenges
Narrative on how the activity is delivering to these

Other Work Programmes
e.g.

- Evidence Base: activity to develop this
- National linkages
- Overlapping opportunities
- Governance
- Stakeholder engagement approach
- International comparators: lessons from overseas

Evidence requirements

Evidence: (where possible data should be by SCMC and by LEP area)	By when	Lead	Source(s)
National policy background: policies effecting the wider ocean economy. Generic and specific to each opportunity.			
For Marine and Maritime, and each of the five opportunities:			
1.1 Drivers for global market growth. How and why the market is set to grow in the next 10-25 years.			
1.2 Global and SCMC share of global market value, GVA and jobs now and 10-25 years.			
1.3 Assets within the SCMC and boardering			
1.4 Comparative strategic advantage of the SCMC.			
1.5 Number and profile of businesses.			
Mapping: (for Marine and Maritime, and for each of the five opportunities, by SCMC and by LEP area)			
Ideas			
1. Up to 10 research specialisms per SCMC organisation for each plus a contact point.			
2. Support for innovation by LEP area.			
3. R&D facilities			
People			
1. Skills provision			
2. Skill gap evidence			
Infrastructure			
2			
3 Business Environment			
4			
5 Places			
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